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㊴ Process for preparing N-aryl or N-aralkyl substituted urethanes.

㊼ N-aryl and N-aralkyl substituted urethanes can be produced by reacting an aryl or aralkyl primary amino compound having a nitro group, a nitroso group or a carbamate group, an organic compound having at least one hydroxyl group, and carbon monoxide in the presence of a catalytic system composed of a metal and/or a compound thereof chosen from palladium, rhodium and ruthenium and compounds thereof serving as catalyst and a Lewis acid and/or a compound thereof as promoter under elevated temperature and high pressure conditions. For instance, the reaction of 2-amino-4-nitrotoluene, ethanol and carbon monoxide in the presence of palladium chloride and a ferrous chloride-pyridine complex under high temperature and high pressure conditions can yield 2,4-diethylcarbamatetoluene.

Croydon Printing Company Ltd.

"Process for Preparing N-aryl or N-aralkyl Substituted Urethanes".

This invention relates to a process for preparing N-aryl or N-aralkyl substituted urethanes. More particularly, it relates to a process for preparing N-aryl or N-aralkyl substituted urethanes by reacting (i) an aryl or aralkyl nitrogen-containing compound, (ii) an organic compound containing at least one hydroxyl group, and (iii) carbon monoxide in the presence of a catalyst.

There have been recently proposed a large number of processes for producing N-aryl or N-aralkyl substituted urethanes by reacting aryl or aralkyl nitro compounds, organic compounds containing at least one hydroxyl group (hereinlater referred to simply as hydroxyl group-containing compound), and carbon monoxide in the presence of catalysts.

For example, U.S. Patent Specification No. 3,338,956 describes a process using rhodium chlorocarbonyl as a catalyst for the urethanation reaction. Further, British Patent Specification No. 1,543,051 discloses a process in which the urethanation reaction is conducted with rhodium chlorocarbonyl as the catalyst and a multi-valent metal halide as the promoter. In these processes, however, aryl or aralkyl nitro compounds are essentially used as the aryl or aralkyl nitrogen-containing compounds to permit the nitro group or groups to take part in the urethanation reaction.

As a result of an extensive study of a process of producing N-aryl and N-aralkyl urethanes, we have found an improved process for producing N-aryl and N-aralkyl substituted urethanes in which the urethanes are produced from specified aromatic aryl and aralkyl primary amine compounds, carbon monoxide and hydroxyl group-containing compounds.

According to the present invention there is provided a process for producing N-aryl or N-aralkyl substituted urethanes by reacting (i) an aryl or aralkyl nitrogen-containing compound, (ii) an organic compound having at least one hydroxyl group, and (iii) carbon monoxide in the presence of a catalyst, characterised in that component (i) is an aryl or aralkyl primary amino compound having a nitro group, a nitroso group or a carbamate group, that the catalyst consists of a catalytic system comprising a metal and/or a compound thereof chosen from palladium, rhodium and ruthenium and compounds thereof and as promoter a Lewis acid and/or a compound thereof, and that the reaction is conducted at elevated temperature and under high pressure conditions.

It is known that if amino compounds having a nitro group as a substituent are subjected to a urethanation reaction in the presence of the catalytic system indicated above, the nitro group can be converted into a carbamate. However, it cannot be expected at all from prior art processes that the amino group is also convertible into a carbamate. It has been also found that where aryl and aralkyl amino compounds which are free of a nitro group, a nitroso group or a carbamate group are used as the starting material, no urethanation reaction takes place. This is a hitherto unknown and rather amazing fact concerning the production of N-aryl or N-aralkyl substituted urethanes from aryl or aralkyl primary amino compounds, carbon monoxide and hydroxyl group-containing compounds.

As mentioned hereinabove, the aryl and aralkyl amino compounds which are employed as the chief starting material are aryl and aralkyl primary amino compounds having a nitro group, a nitroso group or a carbamate group. Examples of such aryl and aralkyl compounds include *m*- and *p*-nitroaniline, *m*- and *p*-nitrosoaniline, *m*- and *p*-carbamateaniline, 2-amino-4-nitrotoluene, 2-amino-4-nitrosotoluene, 2-amino-4-carbamatetoluene, 2-nitro-4-aminotoluene, 2-nitroso-4-aminotoluene, 2-carbamate-4-aminotoluene, 2-amino-6-nitrotoluene, 2-amino-6-nitrosotoluene, 2-amino-6-carbamatetoluene, 4-amino-4'-nitrobiphenyl, 4-amino-4'-nitrosobiphenyl, 4-amino-4'-carbamatebiphenyl, 2-amino-4-nitrobiphenyl, 2-amino-4-nitrosobiphenyl, 2-amino-4-carbamatebiphenyl, 2-nitro-4-aminobiphenyl, 2-nitroso-4-aminobiphenyl, 2-carbamate-4-aminobiphenyl, 4-amino-4'-nitrodibenzyl, 4-amino-4'-nitrosodibenzyl, 4-amino-4'-carbamatedibenzyl, 4-amino-4'-nitrodiphenylmethane, 4-amino-4'-nitrosodiphenylmethane, 4-amino-4'-carbamatediphenylmethane, 4-amino-4'-nitrodiphenyl ether, 4-amino-4'-nitrosodiphenyl ether, 4-amino-4'-carbamatediphenyl ether, bis(2-amino-4-nitrophenyl) ether, bis(2-amino-4-nitrosophenyl) ether, bis(2-amino-4-carbamatephenyl) ether, bis(2-nitro-4-aminophenyl) ether, bis(2-nitroso-4-aminophenyl) ether, bis(2-carbamate-4-aminophenyl) ether, α-amino-α'-nitro-*m*-xylene, α-amino-α'-nitroso-*m*-xylene, α-amino-α'-carbamate-*m*-xylene, α-amino-α'-nitro-*p*-xylene, α-amino-α'-nitroso-*p*-xylene, α-amino-α'-carbamate-*p*-xylene, 1-chloro-2-amino-4-nitrobenzene, 1-chloro-2-amino-4-nitrosobenzene, 1-chloro-2-amino-4-carbamatebenzene, 1-chloro-2-nitro-4-aminobenzene, 1-chloro-2-nitroso-4-amino-benzene, 1-chloro-2-carbamate-4-aminobenzene, 1-amino-5-nitronaphthalene, 1-amino-5-nitrosonaphthalene, 1-amino-5-carbamatenaphthalene and the like. The isomers or homologues of these aryl and aralkyl amino compounds are also usable. These aryl and aralkyl amino compounds may be used singly or in combination. It will be noted that the nitro group of aryl or aralkyl nitro compounds are also converted into a corresponding urethane under reaction conditions used in the practice of the invention. Of the above-mentioned amino compounds, nitroaminotoluenes and aminocarbamatetoluenes are most preferable because these compounds are more reactive than others.

The hydroxyl group-containing compounds useful in the process of the invention include primary, secondary and tertiary monohydric alcohols and polyhydric alcohols and polyhydric alcohols, and monohydric phenols and polyhydric phenols. Typical of such compounds are ethanol and phenol. Suitable alcohols may be expressed by a general formula $R(OH)_{\underline{n}}$ in which R represents a linear or branched alkyl, a cycloalkyl, an alkylene, a cycloalkylene or an aralkyl group, and $\underline{n}$ is 1 or 2 or a higher integer. These alcohols may further include a substituent containing an oxygen, nitrogen, halogen or sulphur atom such as, for example, halogen, sulphoxide, sulpho, amide, carbonyl or a carboxylic acid ester group.

Examples of the alcohols expressed by the general formula $R(OH)_n$ include monohydric alcohols such as methyl alcohol, ethyl alcohol, *n*- and *iso*-propyl alcohol, *n*-, *iso*- and *t*-butyl alcohol, linear or branched amyl alcohol, hexyl alcohol, cyclohexyl alcohol, lauryl alcohol, cetyl alcohol, benzyl alcohol, chlorobenzyl alcohol, methoxylbenzyl alcohol, etc., dihydric alcohols such as ethylene glycol, diethylene glycol, propylene glycol, dipropylene glycol, etc., trihydric alcohols such as glycerol, hexanetriol, etc., and more polyfunctional polyols.

Suitable examples of phenols include phenol itself, chlorophenol, cresol, ethylphenol, linear or branched propylphenol, butyl- and higher alkylphenols, catechol, resorcin, 4,4'-dihydroxydiphenylmethane, 2,2'-*iso*propylidenediphenyl, anthranol, phenanthrol, pyrogallol, phloroglucinol, etc. Of these, methanol, ethanol and *iso*butanol are preferred since the use of these alcohols results in higher velocity of reaction and higher yield of a final product.

The platinum group metals and/or compounds thereof which are used as an integer of the catalytic system in the process of the invention are palladium, rhodium and ruthenium elements or compounds thereof, or a mixture thereof. Examples of such compounds are halides, cyanides, thiocyanides, *iso*cyanides, oxides, sulphates, nitrates, carbonyl compounds of palladium, rhodium or ruthenium, their addition compounds or complexes with tertiary amines such as triethylamine, pyridine, isoquinoline, etc., and their complexes with organic phosphorous compounds such as triphenylphosphine. These catalysts may be used for the reaction as such or may be supported on carriers such as alumina, silica, carbon, barium sulphate, calcium carbonate, asbestos, bentonite, diatomaceous earth, fuller's earth, organic ion-exchange resins, inorganic ion-exchange resins, magnesium silicate, aluminium silicate, molecular sieves and the like. These carriers may be charged into a reactor separately from palladium, rhodium, ruthenium or their compounds. In view of a great catalytic activity, palladium and/or its compounds are preferable to other platinum group metals or compounds thereof.

The Lewis acids and/or compounds thereof are used as the promoter. The term "Lewis acids" herein used is intended to imply those as described, for example, in Physical Organic Chemistry by Jack Hine, 1962 (McGraw Hill Book Co., New York), including Brønsted acids.

Examples of such acids include halides, sulphates, acetates, phosphates, nitrates such as a tin, titanium, germanium, aluminium, iron, nickel, zinc, cobalt, manganese, thallium, zirconium, copper, lead, vanadium, niobium, tantalum, mercury, etc. More particularly, suitable Lewis acids include ferric chloride, ferrous chloride, stannic chloride and copper acetate. Of these, ferrous chloride and ferric chloride are the most preferable. Further, the compounds of the Lewis acids may be, for example, complexes with tertiary amines or organic phosphorous compounds. Examples of such tertiary amines capable of producing complexes include triethylamine, N,N-diethylaniline, N,N-diethylcyclohexylamine, 1,4-diazabicyclo-[2,2,2]octane, and nitrogen-containing heterocyclic compounds such as pyridine, quinoline and isoquinoline. Examples of phosphorous compounds or phosphines include triphenylphosphine, dimethylphenylphosphine, bisdiphenylphosphinoethane and the like. Of these complexes, complexes of ferrous chloride and nitrogen-containing heteroaromatic compounds are preferred since they are less corrosive towards the inside surface of a reactor, can improve the yield of a final product, and permit easier recovery of the catalyst as compared with other promoters.

These complex compounds serve more effectively when used after preparation of the complexes but the starting materials for such complexes may be introduced into the reaction system separately.

If a nitrogen-containing heterocyclic compound is used, aside from the Lewis acid, as the promoter in the reaction system, addition of water in small amount will facilitate the reaction to proceed at a much higher velocity.

It is desirable that the reaction is conducted using the hydroxyl group-containing organic compound and carbon monoxide in such amounts that the hydroxyl group and carbon monoxide are in at least equimolar or greater ratios to the amino group in the case of an amino compound having a carbamate group and/to a total of the amino group and the nitro or nitroso group in the case of an amino compound having a nitro or nitroso group.

The amount of the platinum group metal may widely vary depending on the kind of the amino compound and other reaction conditions but is generally in a range of $1 - 1 \times 10^{-5}$, preferably $5 \times 10^{-1} - 1 \times 10^{-4}$, as metal element, by weight ratio to the amino compound.

The Lewis acid used as the promoter may be used in a range of $2 - 2 \times 10^{-3}$, preferably $1 - 5 \times 10^{-2}$, by weight ratio to the amino compound.

The reaction temperature is generally maintained in a range of 80° - 230°C, preferably 140 - 200°C. The reaction pressure is in the range of 10 - 1000 kg/cm^2 gauge, preferably 30 - 500 kg/cm^2 gauge as expressed in terms of the partial pressure of carbon monoxide. Addition of a small amount of water will shorten the reaction time. In this case, the amount of water added is in a range of 1 - 70 moles, preferably 10 - 50 moles per mole of the starting [redacted] primary amine. An amount less than 1 mole of water per mole of the amino compound does not have an appreciable effect on the reaction time, whereas a larger amount lowers the yield of a final product.

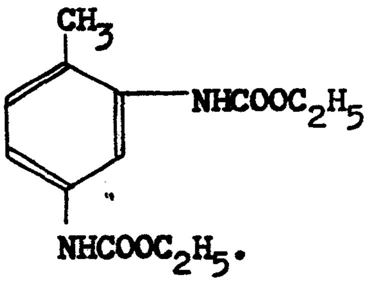
The reaction time depends on the property or kind of the amino compound, reaction temperature, reaction pressure, the kind and amount of the catalyst, amount of water and the type of reactor but is generally in a range of 5 minutes to 6 hours.

After the completion of the reaction, the reaction mixture may be cooled. After discharging the gas from the reaction system, the reaction product may be subjected to a treatment by an ordinary separation technique such as filtration, distillation or other suitable means thereby separating the resulting urethane from unreacted materials, by-products, the solvent and catalyst.

The present invention will be illustrated by the following examples, which should not be construed as limiting thereto the present invention. In the examples, all of the reactions were effected in a stainless steel ("SUS 32"), magnetically agitated autoclave. A comparative example is provided between Examples 2 and 3.

Example 1.

10.33 g of 2-amino-4-nitrotoluene, 68 ml of ethanol, 0.0086 g of palladium chloride, 3.71 g of the ferrous chloridepyridine complex (obtained by interacting one mole of ferrous chloride and two moles pyridine in methanol as solvent), and 0.29 g of water were charged into an autoclave with an inner volume of 200 ml. The air in the autoclave was replaced by nitrogen gas. Then, carbon monoxide was charged into the autoclave under pressure until the initial pressure reached 90 kg/cm^2 gauge. The reaction system was heated under agitation and subjected to the reaction at 165°C for 40 min. After completion of the reaction, the system was allowed to cool to room temperature and, after degassing, the reaction solution was analyzed, revealing that the yield of the diurethane, 2,4-diethylcarbamate toluene, was 84.6%. The diurethane produced has the formula



<u>Example 2.</u>

7.8 g of 2-amino-4-ethylcarbamatetoluene, 6.0 ml of ethanol, 0.02 g of palladium chloride, and 8.8 g of ferrous chloride-pyridine complex were charged into an autoclave with an inner volume of 200 ml. Carbon monoxide was charged into the reaction system until the initial pressure reached 70 kg/cm^2 gauge to undergo the reaction at 160°C for 240 minutes. After completion of the reaction, the reaction solution was analyzed, with the result that the yield of the diurethane, 2,4-diethyl carbamate toluene, was 20%.

Comparative Example.

6.3 g of aniline, 68 ml of ethanol, 0.02 g of palladium chloride, and 7.42 g of ferrous chloride-pyridine complex were charged into an autoclave with an inner volume of 200 ml, followed by the urethanation reaction under an initial pressure of carbon monoxide of 90 kg/cm^2 gauge at 165°C for 240 minutes. After completion of the reaction, the reaction solution was analyzed, with the result that no N-phenylethylcarbamate was detected.

Examples 3 - 8.

Various amino compounds other than 2-amino-4-ethylcarbamatetoluene were used to conduct the urethanation reaction in the same manner as in Example 1 using an initial pressure of 90 kg/cm^2 gauge, a reaction temperature of 165°C and other reaction parameters indicated in the Table below. The results are also shown in the Table.

Table

Example No.	Amino Compound	Amount (g)	Alcohol	Amount (ml)	Water (g)	$PdCl_2$ (g)	$FeCl_2$-(pyridine)$_2$ (g)	Reaction time (min)	Yield of corresponding diurethane (%)
3	m-nitroaniline	9.7	ethanol	68	0.27	0.008	2.2	40	85
4	p-nitroaniline	9.7	"	"	"	"	"	"	80
5	m-ethylcarbamate-aniline	12.5	"	"	0	0.032	6.3	240	20
6	4-amino-2-nitrotoluene	10.7	"	"	0.30	0.009	2.5	40	85
7.	4-amino-2-ethylcarbamate-toluene	13.6	"	"	0	0.035	6.8	240	20
8	2-amino-4-isobutylcarbamate-toluene	15.6	isobutanol	"	0	0.040	7.8	240	30

CLAIMS:

1. A process for producing N-aryl or N-aralkyl substituted urethanes by reacting (i) an aryl or aralkyl nitrogen-containing compound, (ii) an organic compound having at least one hydroxyl group, and (iii) carbon monoxide in the presence of a catalyst, characterised in that component (i) is an aryl or aralkyl primary amino compound having a nitro group, a nitroso group or a carbamate group, that the catalyst consists of a catalytic system comprising a metal and/or a compound thereof chosen from palladium, rhodium and ruthenium and compounds thereof and as promoter a Lewis acid and/or a compound thereof, and that the reaction is conducted at elevated temperature and under high pressure conditions.

2. A process according to Claim 1, wherein component (i) is an aryl primary amino compound.

3. A process according to Claim 1 or Claim 2, wherein component (i) has a nitro group.

4. A process according to any preceding claim, wherein the metal and/or a compound thereof is palladium and/or a compound thereof.

5. A process according to any preceding claim, wherein the promoter is ferrous chloride and/or a compound thereof or ferric chloride and/or a compound thereof.

6. A process according to any one of Claims 1 to 4, wherein the promoter is a complex of ferrous chloride and a nitrogen-containing heterocyclic compound.

7. A process according to Claim 6, wherein water is added to the reaction system in an amount of 1 - 70 mole % per mole of component (i).

8. A process according to any preceding claim, wherein component (ii) is a compound having the general formula $R(OH)_{\underline{n}}$ in which R represents a linear or branched alkyl, a cycloalkyl, an alkylene, a cycloalkylene or an aralkyl group and <u>n</u> is 1 or 2 or a higher integer, the compound optionally being substituted by a substituent containing oxygen, nitrogen, halogen or sulphur atom.

9. A process according to any preceding claim, wherein component (i) is a nitroaminotoluene or an aminocarbamatetoluene.

10. A process according to any preceding claim, wherein component (i) is chosen from 2-amino-4-nitrotoluene, 2-amino-4-ethylcarbamatetoluene, <u>m</u>-nitroaniline, <u>p</u>-nitroaniline, <u>m</u>-ethylcarbamateaniline, 4-amino-2-nitrotoluene, 4-amino-2-ethylcarbamatetoluene and 2-amino-4-<u>iso</u>butylcarbamatetoluene.

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EUROPEAN SEARCH REPORT

Application number

EP 78 30 0188

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
X	NL - C - 94 613 (DE BATAAFSCHE PETROLEUM) * First claim * --	1-10
X	CHEMICAL ABSTRACTS, vol. 77 (1972) 87801y. * The whole abstract * ----	1-10

CLASSIFICATION OF THE APPLICATION (Int. Cl.²)

C 07 C 125/06

TECHNICAL FIELDS SEARCHED (Int.Cl.²)

C 07 C 125/06

CATEGORY OF CITED DOCUMENTS

- X: particularly relevant
- A: technological background
- O: non-written disclosure
- P: intermediate document
- T: theory or principle underlying the invention
- E: conflicting application
- D: document cited in the application
- L: citation for other reasons
- &: member of the same patent family, corresponding document

☒ The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24-10-1978	GAUTIER

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